



The EMU vs. The Astronaut



EIS Then and Now

Tracking the Human-Suit Interface

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The Problem

- Over the years we have identified several significant injuries
 - Shoulder injuries (Slap, rotator cuff)
 - Knee injuries (meniscal tears)
 - Fingernail Delamination
 - What else?





Document to Prevent



- EIS

dev-mmis.ndc.nasa.gov

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APPLICATION IN SYSTEM TESTING

Exercise Injury System

Home Admin ASCR NBL Doctor

NBL Home Exposures Dive Profiles Conditions Divers Manage Selection Lists

Create NBL Exposure

Diver
 ☐ Include Inactive

Event Date

Exposure Duration (hh:mm)

Comments

B **I** **U**

Characters: 3

Total Inverted Time (hh:mm)

Hut Type
☐ Pivoted ☐ Planar

Wrist Bearing Type
☐ Aluminum ☐ Steel

Shoulder Harness Used
☐ True ☐ False

Shoulder Pads Used
☐ True ☐ False

Used Teflon Inserts
☐ True ☐ False

Locations Iced
☐ Right Shoulder
☐ Left Shoulder
☐ Deferred

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[Leave Feedback](#)



Sometimes We Fail





EIS



- We have learned a lot
 - Shoulder injury prevention
 - ASCR Conditioning
 - Inverted Ops
 - Minimize repeated failed attempts
- But learned from injury
 - Attributed to the suit



EIS 2.0



- Desire to learn more about the “pre-exposure” subject (vs. suit)
 - Prone to injury?
 - Sleep?
 - Hydration?
 - Activity level and type
 - Are they ready/fit?
 - Preexisting injury?

The screenshot displays the 'Exposure Incident System 4.0' web application. The page title is 'Dive Exposure - Astronaut X'. The form is divided into several sections with tabs for 'Pre-Built Exposure', 'Pre-Built Diving', 'During Built Exposure', 'Post-Built Exposure', 'Follow Up', 'Issues', and 'Conditions'. The 'Pre-Built Exposure' tab is active, showing a form with the following fields:

- Date and Time (MM/DD/YYYY HH:MM):** 7/15/2024 10:07
- Subject:** Astronaut - Unassigned
- Mission:**
- Exposure Type:** NBL EVA Training
- Location Of Exposure:** NBL
- NBL Run Time:** CB EVA Pave (Rev. 301C SPDM LUGB44)
- TD, P, Tank Content Percent:** Not Assigned
- Suit Type:** GML - Mars
- Suit Engineer:** Roger Chalmers
- HUT Name:** NBL
- OFF-Nominal:** Not Assigned
- Shoulder Protection Used:** Not Assigned
- Glove Used:** Phase V
- Waist Bearing Used:** Astronaut
- LTA Used:** GML LTA
- Boot Used:** GML Boot
- Pressure Used:** 4.0-4.5 PSI

At the bottom of the form, there are two buttons: 'Pre-Built Exposure' and 'Back to List'.



EIS 2.0



Create Sanders, Robert W. USO-SD3|WYLLIE LABORATORIES... Details 401 - Unauthorized: Access is denied due to invalid...

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Exposure Incident System 4.0 Home NBL Doctor

[NBL Home](#) [NBL Exposure](#) [Exposure Data Profiles](#) [Conditions](#) [Subjects](#) [Manage Associated Links](#)

Welcome NDCurwindsen!

[Leave Feedback](#)

Dive Exposure - Astronaut X

[Pre-Suited Exposure](#) [Pre-Suit Donning](#) [During Suited Exposure](#) [Post Suited Exposure](#) [Follow Up](#) [Issues](#) [Conditions](#)

[Edit Pre-Suited Exposure](#) [Back to List](#)

Date and Time (MM/DD/YYYY hh:mm):
7/15/2024 15:07

Subject:
Astronaut - UnAssigned

Mission:

Exposure Type:
NBL EVA Training

Location Of Exposure:
NBL

NBL Run Title:
CB EVA Hired Flex (B1C SPOM LUBE4)

TD, PI, Task Contact Person:
Frankie

Suit Type:
EMU - Planar

Suit Engineer:
Roger Graham

HUT Size:
Med

OFF-Nominal:
Not Answered

Shoulder Protection Used:
Harness

Glove Used:
Phase V

Wrist Bearing Used:
Aluminum

LTA Used:
EMU LTA

Boot Used:
EMU Boot

Pressures Used:
4.0-4.3 PSI

[Edit Pre-Suited Exposure](#) [Back to List](#)



EIS 2.0



Create

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Exposure Incident System 4.0

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Welcome NDC/nwsander!

Logout Feedback

Dive Exposure - Astronaut X

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Date and Time (MM/DD/YYYY hh:mm):

7/15/2024 15:07

Subject:

Astronaut - UnAssigned

Mission:

Exposure Type:

NBL EVA Training

Location Of Exposure:

NBL

NBL Run Time:

CB EVA Hired New (BMC SPOM LUBE4)

TD, PI, Task Contact Person:

Frankie

Suit Type:

EMU - Planar

Suit Engineer:

Roger Graham

HUT Size:

Med

OFF-Nominal:

Not Answered

Shoulder Protection Used:

Harness

Glove Used:

Phase V

Wrist Bearing Used:

Aluminum

LTA Used:

EMU LTA

Boot Used:

EMU Boot

Pressures Used:

4.0-4.3 PSI

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Dive Exposure - Astronaut X

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Are you hydrated?

Yes

Are you fed?

Yes

Can you clear your ears?

Yes

Are your sinuses clear?

Yes

Did you get sufficient sleep last night?

Yes

Total hours of sleep (hours):

7.5

Do you have any pain, discomfort, or injuries to report prior to donning the suit?

No

Do you participate in any leisure time or ASCR prescribed physical activity?

Not Answered

Exercises

Type	Frequency	Intensity	Duration
Cycling	1-2 times per week	Vigorous	45-60 minutes
Functional Fitness	1-2 times per week	Vigorous	45-60 minutes
Running/Jogging	1-2 times per week	Vigorous	45-60 minutes
Swimming	1-2 times per week	Vigorous	45-60 minutes

Other Activities:

Pre-exposure intervention therapies used:

- Non-Prescription Medications (e.g. Ibuprofen)
- NBL Hardener

Other pre-exposure intervention therapies:

Indicate all other countermeasures (e.g., padding, moleskin, etc.):

Change in countermeasures was only for this suit exposure

Not Answered

Edit Pre-Suit Donning

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EIS 2.0



Create

At records view

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Build a

Manage Rotation (1/1)

Dive Exposure -- Astronaut X

Pre-Suited Exposure

Pre-Suit Donning

During Suited Exposure

Edit Pre-Suited Exposure

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Date and Time (MM/DD/YYYY hh:mm):

7/15/2024 15:07

Subject:

Astronaut - UnAssigned

Mission:

Exposure Type:

NBL EVA Training

Location Of Exposure:

NBL

NBL Run Time:

CB EVA Hired Max (BMC SPOM LUBE4)

TD, PI, Task Contact Person:

Frankie

Suit Type:

EMU - Planar

Suit Engineer:

Roger Graham

HUT Size:

Med

OFF-Nominal:

Not Answered

Shoulder Protection Used:

Harness

Glove Used:

Phase V

Wrist Bearing Used:

Aluminum

LTA Used:

EMU LTA

Boot Used:

EMU Boot

Pressures Used:

4.0-4.3 PSI

Edit Pre-Suited Exposure

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Dive Exposure -- Astronaut X

Pre-Suited Exposure

Pre-Suit Donning

During Suited Exposure

Edit Pre-Suit Donning

Back to List

Are you hydrated?

Yes

Are you fed?

Yes

Can you clear your ears?

Yes

Are your sinuses clear?

Yes

Did you get sufficient sleep last night?

Yes

Total hours of sleep (hours):

7.5

Do you have any pain, discomfort, or injuries to report prior to donning?

No

Do you participate in any leisure time or ASCR prescribed physical activity?

Not Answered

Exercises

Type	Frequency
Cycling	1
Functional Fitness	1
Running/Jogging	1
Swimming	1

Other Activities:

Pre-exposure intervention therapies used:

- Non-Prescription Medications (e.g. Ibuprofen)
- Nail Hardener

Other pre-exposure intervention therapies:

Indicate all other countermeasures (e.g., padding, moleskin, etc.):

Change in countermeasures was only for this suit exposure?

Not Answered

Edit Pre-Suit Donning

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Dive Exposure -- Astronaut X

Pre-Suited Exposure

Pre-Suit Donning

During Suited Exposure

Post Suited Exposure

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Edit Post-Suit Exposure

Back to List

Total Time Suited (hh:mm):

05:45

Number of times HUT donned:

1

Total UNplanned doffing events:

0

For all Don events:

Left Lower Arm: Attached

Right Lower Arm: Attached

For all Doff events:

Left Lower Arm: Attached

Right Lower Arm: Attached

Total Time Pressurized (hh:mm):

05:45

Total Time Inverted (hh:mm):

00:00

Do you have any pain, discomfort, or injuries to report?

Yes

Post-exposure therapies administered:

- Declined

Isolator Locations:

- Deferred

Other post-exposure therapies:

Are additional countermeasures recommended to be added or removed for subsequent suited events?

Not Answered

Additional Comments

Edit Post-Suit Exposure

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Audit History



EIS 2.0



Create

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Dive Exposure -- Astronaut X

Pre-Suited Exposure

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During Suited Exposure

Edit Pre-Suited Exposure

Back to List

Date and Time (MM/DD/YYYY hh:mm):
7/15/2024 15:07

Subject:
Astronaut - UnAssigned

Mission:

Exposure Type:
NBL EVA Training

Location Of Exposure:
NBL

NBL Run Time:
CB EVA Hired Rev (BPC SPOM LUBE4)

TD, PI, Task Contact Person:
Pawlicki

Suit Type:
EMU - Planar

Suit Engineer:
Roger Graham

HUT Size:
Med

OFF-Nominal:
Not Answered

Shoulder Protection Used:
Harness

Glove Used:
Phase V

Wrist Bearing Used:
Aluminum

LTA Used:
EMU LTA

Boot Used:
EMU Boot

Pressures Used:
4.0-4.3 PSI

Edit Pre-Suited Exposure

Back to List

Dive Exposure -- Astronaut X

Pre-Suited Exposure

Pre-Suit Donning

During Suited Exposure

Edit Pre-Suit Donning

Back to List

Are you hydrated?
Yes

Are you fed?
Yes

Can you clear your ears?
Yes

Are your sinuses clear?
Yes

Did you get sufficient sleep last night?
Yes

Total hours of sleep (hours):
7.5

Do you have any pain, discomfort, or injuries to report prior to donning?
No

Do you participate in any leisure time or ASCR prescribed physical acti
Not Answered

Exercises

Type		F
Cycling		1
Functional Fitness		1
Running/Jogging		1
Swimming		1

Other Activities:

Pre-exposure intervention therapies used:

- Non-Prescription Medications (e.g. Ibuprofen)
- Nail Hardener

Other pre-exposure intervention therapies:

Indicate all other countermeasures (e.g., padding, mo'le skin, etc.):

Change in countermeasures was only for this suit exposure
Not Answered

Edit Pre-Suit Donning

Back to List

Dive Exposure -- Astronaut X

Pre-Suited Exposure

Pre-Suit Donning

During Suited Exposure

Post Su

Edit Post-Suit Exposure

Back to List

Total Time Suited (hh:mm):
05:45

Number of times HUT donned:
1

Total Unplanned doffing events:
0

For all Don events:
Left Lower Arm: Attached
Right Lower Arm: Attached

For all Doff events:
Left Lower Arm: Attached
Right Lower Arm: Attached

Total Time Pressurized (hh:mm):
05:45

Total Time Inverted (hh:mm):
00:00

Do you have any pain, discomfort, or injuries to report?
Yes

Post-exposure therapies administered:

- Declined

Isot Locations

- Deferred

Other post-exposure therapies:

Are additional countermeasures recommended to be added or removed for subseq
Not Answered

Additional Comments

Edit Post-Suit Exposure

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Dive Exposure -- Astronaut X

Pre-Suited Exposure

Pre-Suit Donning

During Suited Exposure

Post Suited Exposure

Follow Up

Issues

Conditions

Edit Issues

Back to List

Body Location	Time Frame	Pain Scale	Symptoms	Signs	Isot Location	Comments
Left Hand - Finger(s)	During	1	• None	• None	No	Small fingers shaking post-run. "gloves too big - they play my fingers too much."
Right Hand - Finger(s)	During	1	• None	• None	No	Small fingers shaking post-run. "gloves too big - they play my fingers too much."

Audit History



Create

Exposure Incident System 4.0

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NBL Exposures

Historical Dive Profiles

Dive Exposure - Astronaut X

Pre-Suited Exposure

Pre-Suit Donning

Quit

Edit Pre-Suited Exposure

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Date and Time (MM/DD/YYYY hh:mm):

7/15/2024 15:07

Subject:

Astronaut - Unassigned

Mission:

Exposure Type:

NBL EVA Training

Location Of Exposure:

NBL

NBL Run Time:

CB EVA Hired New (BMC SPOM LUBE4)

TD, PI, Task Contact Person:

Frankie

Suit Type:

EMU - Planar

Suit Engineer:

Roger Graham

HUT Size:

Med

OFF-Nominal:

Not Answered

Shoulder Protection Used:

Harness

Glove Used:

Phase V

Wrist Bearing Used:

Aluminum

LTA Used:

EMU LTA

Boot Used:

EMU Boot

Pressures Used:

4.0-4.3 PSI

Edit Pre-Suited Exposure

Back to List

Dive Exposure - Astronaut X

Pre-Suited Exposure

Pre-Suit Donning

Quit

Edit Pre-Suit Donning

Back to List

Are you hydrated?

Yes

Are you fed?

Yes

Can you clear your ears?

Yes

Are your sinuses clear?

Yes

Did you get sufficient sleep last night?

Yes

Total hours of sleep (hours):

7.5

Do you have any pain, discomfort, or injury?

No

Do you participate in any leisure activities?

Not Answered

Exercises

Type

Docking

Functional Fitness

Running/Jogging

Swimming

Other Activities:

Pre-exposure intervention therapies:

- Non-Prescription Medication
- NBL Hardener

Other pre-exposure interventions:

- Indicates all other countermeasures

Change in countermeasures:

- Not Answered

Edit Pre-Suit Donning

Back to List

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Create

Sanders, Robert W. (JSC-SD3)(WYL...

NBL Home

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Exposure Incident System 4.0

Home

NBL

Doctor

Welcome NDC\rsanders1!

Leave Feedback

NBL Home

NBL Exposures

Historical Dive Profiles

Conditions

Subjects

Manage Selection Lists

Common Activities

Create Dive Exposure

Create 1G Exposure

Recent NBL Exposures

	Full Name	Exposure Date	Event Description	Lab	Location of Exposure	Suit Used	LTA Used	Conditions	Actions
<div>Details</div>			1G - NBLWet	NBL EVA/ISS Procedure Development	NBL	EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G - NBLWet	NBL EVA/ISS Procedure Development	NBL	EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G -	Mission Training		EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	<div>Add Condition</div>
<div>Details</div>			1G - NBLWet	NBL EVA Training	NBL	Z-2	EMU LTA	0	<div>Add Condition</div>

Latest NBL Exposures Resulting in a Condition Report

	Subject	Date	Event Description	Condition
<div>Exposure</div> <div>Condition</div>			1G - NBLWet	Bilateral thumb pain 2/2 glove fit issues and "break points" got to point where GM preferred to truncate run, and requested pain meds
<div>Exposure</div> <div>Condition</div>			1G - NBLWet	Subconjunctival Hematoma noted after run possibly due to inverted time
<div>Exposure</div> <div>Condition</div>			1G - NBLWet	after the run, the patient complains of pain over her left shoulder, especially in the deltoid region. Patient states throughout the run. She felt



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Details

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Welcome NDC\rsanders1!

Leave Feedback

Exposure

Follow Up

Issues

Conditions

Signs	Local Location	Comments
<div>• None</div>	No	Small fingers shaking post-run. "gloves too big - they play my fingers too much."
<div>• None</div>	No	Small fingers shaking post-run. "gloves too big - they play my fingers too much."



Still just learning from mistakes...

- Modelling can *prevent* the need to learn from “mistakes”
 - Proactive
 - Prevent or Decrease injuries
 - New Suit Design – Injury ***prevention***
 - No Need to expose personnel to suit to learn



Modelling is a Solid Answer

- What we know is from EMU in NBL
 - vetted in microgravity.
 -
- No new injury patterns "discovered" in space,
 - our process is "working"
- Imagine the benefit to modeling the suit-human interface...
 - to guide suit use and astronaut training in preventive measures without ever having to injure a crew member
 - For planetary missions, there is no equivalent analog... modeling is our only option



Thank You!

- *There is no perfect suit... There is no perfect human, but with the proper modeling, we may create the ideal human-suit interface ... with virtually all injuries made a thing of the past!*

- Questions?

